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AFOEHL REPORT 90-173EQ00183KPW

AD-A228 804

Drinking Water Disinfection Survey
Stewart ANGB NY

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October 1990

Final Report

AF Occupational and Environmental Health Laboratory (AFSC)
Human Systems Division
Brooks Air Force Base, Texas 78235-5501

90

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REPORT DOCUMENTATION PAGE

Form Approved
OMB No 0704-0188

1. AGENCY USE ONLY *(Leave blank)*

2. REPORT DATE
1990 October

3. REPORT TYPE AND DATES COVERED
Final 9-11 July 1990

4. TITLE AND SUBTITLE
Drinking Water Disinfection Survey, Stewart ANGB NY

5. FUNDING NUMBERS

6. AUTHOR(S)
Darrin L. Curtis, 1Lt, USAF, BSC
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7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
~~AF~~ Occupational and Environmental Health Laboratory
Brooks AFB TX 78235-5501

8. PERFORMING ORGANIZATION REPORT NUMBER
AFOEHL Report
90-173EQ00183KPW

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Same as Blk 7

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Statement A. Unlimited, approved for public release

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

The AFOEHL conducted a drinking water disinfection survey at Stewart ~~ANG~~ base from 9-11 July 1990. The scope of the survey included investigating and sampling the base water distribution system. The objectives of the survey were to evaluate the following areas: source water quality, treatment processes, distribution system and layout, water use trends, and monitoring procedures. Samples were analyzed for Total Trihalomethane (TTHM), Maximum Total Trihalomethane Potential (MPT), Total Organic Carbon (TOC), and Total Organic Halides (TOX).

Recommendations: (1) Pursue legal and/or contractual means to obtain source water which meets Federal and State standards. (2) Switch the disinfectant from chlorine to chloramines. Alternatively, install an air stripping unit or install a drinking water distribution system.

14. SUBJECT TERMS
Trihalomethanes Drinking Water Stewart ANG Base
Disinfection By-Products

15. NUMBER OF PAGES
39

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	none

NSN 7540-01-280-5500

Standard Form 298 (Rev 2-89)
Prescribed by ANSI Std Z39-18
298-102

ACKNOWLEDGEMENTS

The authors greatly appreciate the technical expertise and hard work provided by the other members of the Bioenvironmental Engineering Division at AFOEHL.

We also acknowledge the staff of the Stewart ANG bioenvironmental engineering service for their help in preparing this report. Thanks for making us feel welcome.

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I. INTRODUCTION

On 30 April 90, Headquarters 105th Military Airlift Group, Commander, Stewart Air National Guard Base, requested the Air Force Occupational and Environmental Health Laboratory (AFOEHL) identify causes and recommend solutions to an abnormal water quality condition at Stewart Air National Guard Base.

The objectives of the survey were to evaluate the following areas:

a. Source water quality.
b. Treatment processes.
c. Distribution system and layout.
d. Water use trends.
e. Monitoring procedures.

The major concerns are the formation of trihalomethanes (THM) in the drinking water, the chlorine residual in the drinking water, and the presence of bacteria in the distribution system.

1Lt Darrin L. Curtis and SMSgt E. John Randall conducted the survey 9-11 July 1990. During the survey, the AFOEHL team collected data from past records and took samples.

II. DISCUSSION

A. Introduction

The 105th Military Airlift Group is the host organization with a C-5 aircraft mission. The 42nd Marine Aircraft Group, Det D, is the only tenant organization and has a KC-130T aircraft mission. Total daily population is over 800 and peaks at 1700 during monthly unit training assemblies.

The base, including all utility systems, is new. Construction started in 1984. Occupancy of buildings started in October 1987 and continued as each of the current 13 buildings were completed.

The base stores its water in two 250,000-gallon tanks. The same tanks and water lines are used for supplying water to both buildings and the fire suppression system. The base receives treated water from the surrounding communities. The base also chlorinates water maintained in the base water tanks.

Stewart purchases its drinking water from the townships of New Windsor and Newburgh, New York. New Windsor purchases part of its drinking water from Newburgh NY. The Newburgh Water Treatment Plant draws its water from a surface source, Lake Washington, and the raw water is treated by coagulation, sedimentation, filtration, and disinfection.

Base medical personal first detected abnormal potable water conditions in the buildings in September 1988. Several buildings experienced varying degrees of low to nonexistent residual chlorine, periodic coliform bacteria presence, and noncoliform bacteria growth. Attempts to correct these conditions included raising the chlorine levels in the storage tanks and rerouting the water flow to some of the buildings. These actions and the colder weather in the winter months did reduce the abnormal conditions; however, some of these same buildings are now experiencing unacceptable levels of THMs.

B. Background

1. The Environmental Protection Agency and World Health regulations define water disinfection as the absence of an indicator coliform bacteria group. Disinfection techniques are roughly classified into two types: chemical and physical. Chemical disinfectants for water include chlorine and other halogens, chlorine dioxide, chloramine, hydrogen peroxide and ozone. Physical disinfection methods include ultraviolet light, fine filtration, heat, ultrasound and ionizing radiation.[2]

2. THMs

Chlorine has been the traditional choice of disinfection of public water supplies.[4] Dissolved in water, chlorine forms hypochlorous acid, which in turn disassociates into a hydrogen ion and a hypochlorite ion. Although it is not known exactly how chlorine destroys microorganisms, it is assumed that chlorine inhibits essential cell enzyme systems through oxidation.[2] Disinfection with chlorine has virtually eliminated incidences of cholera and typhoid, and incidences of water diseases are now usually the result of insufficient or inadequate disinfection or some breakdown in the disinfection process.

Point-of-entry chlorine injection is an effective method of treating water problems. It reduces iron and manganese and controls hydrogen sulfide, iron- and sulfate-reducing bacteria, and also controls taste and odor problems. When chlorine is injected into water, however, it produces a by-product called THM.[14]

THMs are one of the most widespread contaminants in chlorinated municipal water supplies. THMs currently include chloroform, bromodichloromethane, dibromochloromethane and bromoform. Chlorine reacts with naturally-occurring humic substances in water forming THMs, mainly chloroform. Chloroform has been shown to cause cancer in laboratory animals and it is a suspected human carcinogen, even at low levels.[10,14]

THM precursors, called humic substances, are measured as non-purgeable total organic carbons (NPTOC).[14] Precursor is defined as a "formation potential" that must always be accompanied by a stated specific set of reaction conditions. Generally, the higher the NPTOC level, the higher the THM formation.[19]

Humic substances are a mixture of poorly biodegradable decomposition products of natural organic matter produced by both plants and animals.[18] Aquatic humic substances, composed of humic and fulvic acids, account for approximately 50 percent of the dissolved organic carbon in most natural waters.[1]

The maximum trihalomethane formation potential (MTP) of a water supply is influenced by such factors as NPTOC, chlorine dosage, contact time, temperature and pH.[14] The most important chemical variable in chlorination by-product formation is pH.[19] Trihalomethane formation is greater in surface water than in ground water, since surface water contains higher levels of humic substances.[14]

THMs are presently regulated at 100 micrograms per liter (μg/L), although the standard only applies to water systems that serve a population of 10,000 or more individuals and which add a disinfectant (oxidant) to the water in any part of the drinking water treatment process under 40 CFR 141.12 (excluding AFR 161-44(C2) and 10 NYCRR which do require monitoring if the system is a community water system). U.S. Environmental Protection Agency (USEPA) is currently reviewing the THM standard. We expect them to lower it to 50 μg/L, or 25 μg/L for each of the four THMs. In addition to reevaluating the THM regulations, the EPA is scheduled to promulgate maximum contaminant levels for various disinfection by-products (DBPs) in 1991.[11]

Water with high bromide levels can cause a shift in the production of THMs to the more brominated species.[4,8]

Several researchers have also shown that when raw water or humic substances extracted from natural waters are chlorinated, other halogenated organic compounds in addition to trihalomethanes are produced. The nature of the specific organic halides formed, the possibility of any adverse health effects associated with their presence, and the extent of their formation relative to the regulated THMs are areas of current research.[17]

Under a grant from the American Water Works Association Research Foundation, the Metropolitan Water District of Southern California conducted a survey in early 1987 to determine the presence of THMs in utilities serving more than 10,000 people. The survey showed that the 1984-86 national total trihalomethane (TTHM) average was 42 μg/L and that 3 percent of the water utilities surveyed were not in compliance with the existing maximum contaminant level (MCL). The survey also found that these utilities would fail to comply with TTHM standards as strict as 50, 25, and 5 μg/l at levels of 26, 60, and 82 %, respectively.[11]

The parameter TOX represents the concentration of total organic halides in a water sample. It is a collective parameter that is being used increasingly as a surrogate for potentially harmful halogenated organic substances in drinking water. Ratios of TOX to THM of 3 to 10 have been measured for various waters, depending on treatment conditions. TOX itself is not currently regulated in finished drinking water.[17]

3. Stewart ANG Water System

The water distribution system at Stewart is designed for fire fighting suppression. There is approximately one mile of 24-inch lines in the system along with other large lines. Engineers first designed the system with a separate drinking water line, but the water line was eliminated for cost purposes. At any one time there are approximately 250,000 gallons of water in the distribution systems lines. The daily average consumption is from 20,000 to 25,000 gallons a day. The daily average drill weekend flow is from 30,000 to 35,000 gallons a day. These numbers show that the average detention time is approximately 10 days with a range of from 7 to 12 days.

C. AFOEHL/EQW Sampling Procedures

The general sampling protocol consisted of collecting samples at the influent of the base and at several representative points on the water distribution system. Aerators were removed from faucets and the water was allowed to flush for 5-10 minutes prior to collecting the samples. Temperature, pH and chlorine concentrations were measured at the time of sample collection.

Samples analyzed to determine the instantaneous THM concentration were collected in 40-mL bottles with screw-on caps containing a teflon lined septum. These samples were dosed with sodium thiosulfite crystals (for dechlorination), filled head space free, sealed and refrigerated at 4°C until they were submitted for subsequent analysis of TTHM. Each of these samples was collected in duplicate for quality assurance/quality control requirements.

A second set of samples was collected at selected sites to determine the MTP levels. These samples were also collected in 40-mL bottles but were dosed with approximately 2-3 mg of sodium hypochlorite at the time of collection. The bottles were then sealed head space free and stored for seven days at room temperature, after which they were analyzed for MTP.

We collected TOX samples to measure organic halides containing chlorine, bromine, and iodine by collecting samples in 250-mL amber bottles with screw-on caps having a teflon liner. These samples were filled headspace-free and sealed for subsequent TOX analysis.

Total organic carbon (TOC) samples were collected in 1-liter polyethylene containers, preserved with sulfuric acid to a pH $<$ 2.0 and cooled to 4°C.

Water samples for bromide analysis were collected in 1-liter polyethylene containers. No preservatives were used.

Temperature, pH, chlorine levels were measured on-site. Free available and total residual chlorine concentrations as well as pH were measured with a colorimetric comparator kit which employed DPD tablets (LaMotte DPD Chlorine Detection Kit).

D. Sites

AFOEHL sampled eight sites, Table 1, seven sites for two days and one site for one day. The sites were selected because they were important water usage sites or they represented maximum detention time. The base map in Appendix A shows the major building locations.

TABLE 1
SITE DESCRIPTIONS
STEWART ANG BASE NY - WATER QUALITY SURVEY
AFOEHL ENVIRONMENTAL QUALITY DIVISION

BUILDING	SITE IDENTIFIER	DESCRIPTION
100	0183-PD-001	CAMS Hangar
102	0183-PD-002	Fuel Cell Hangar
108	0183-PD-023	Utility Center
110	0183-PD-021	Pump Station
202	0183-PD-010	Squadron Operations
203	0183-PD-012	People Center (Dining Hall)
403	0183-PD-017	POL Operations
N/A	0183-PD-019	Aircraft Watering Point

E. Analyses

We analyzed the water system for Total Organic Carbon (TOC), Total Organic Halides (TOX), Total Trihalomethane (TTHM), and Maximum Total Trihalomethane Potential (MTP). Methods used were as follows:

Analysis	Method
TOC	EPA 415
TOX	EPA 846
TTHM	EPA 501.1
MTP	EPA 501.1

(Note: We changed EPA 501.1 for MTP according to the modification in CFR 141.30, Appendix C, Part III.) The sampling log is at Appendix B.

F. Regulations Concerning THMs

Stewart is a "public water system" and considered a "nontransient noncommunity water system (NTNC)" according to EPA definitions in 40 CFR 140.1 and Chapter I, Part 5 of the New York state sanitary code. With the implementation of the new state sanitary code, a NTNC will be considered a community water system (CWS) when there is no regulation for a NTNC. Community water systems must average the four most recent sets of quarterly samples to determine their compliance with the MCL of 0.10 mg/l. A CWS must report their noncompliance to the state within 30 days of the public water system's receipt of the analyses. The base is considered a noncommunity water system under the states current regulations but will change to a CWS within the next year when THMs are involved.

The Air Force Regulation implementing the Safe Drinking Water Act (SDWA) sampling and public notification is AFR 161-44.

G. Survey Results: The survey results are shown in Tables 2, 3, and 4.

TABLE 2
TEMPERATURE, CHLORINE, pH
AND TRIHALOMETHANE SAMPLE RESULTS

BLDG	DATE	(°F) TEMP	FAC (ppm)	TRC (ppm)	pH	TTHM (μg/L)
100	10 Jul 90	76	0.0	0.0	7.5	111.9
	11 Jul 90	61	0.0	0.0	7.5	110.1
102	10 Jul 90	60	0.0	0.0	7.3	127.1
	11 Jul 90	68	0.0	0.0	7.3	127.3
108	10 Jul 90	62	0.6	0.8	7.3	123.0
	11 Jul 90	62	0.5	0.6	7.3	117.3
110	10 Jul 90	60	0.1	0.2	7.3	98.7
	11 Jul 90	60	0.0	0.0	7.3	81.6
202	10 Jul 90	66	0.0	0.0	7.5	124.1
	11 Jul 90	65	0.0	0.0	7.5	120.2
203	10 Jul 90	64	0.2	0.4	7.5	105.7
	11 Jul 90	62	0.2	0.4	7.5	123.5
403	10 Jul 90	60	0.0	0.0	7.5	128.6
	11 Jul 90	60	0.0	0.0	7.5	120.2
*019	11 Jul 90	65	0.0	0.0	7.8	104.6

*Site 019 refers to the Aircraft Watering Point.

TABLE 3
BROMIDE, TOC, AND TOX SAMPLE RESULTS
Results in milligrams per liter (mg/L)

LOCATION	BLDG	DATE	BROMIDES	TOC	TOX
Utility Center	108	10 Jul 90	< 0.1	4.0	0.194
		11 Jul 90	< 0.1	---	---
Pumphouse	110	10 Jul 90	< 0.1	4.0	0.398
		11 Jul 90	< 0.1	---	0.193
Aircraft Watering Point	N/A	10 Jul 90	---	---	---
		11 Jul 90	< 0.1	---	---

TABLE 4
MAXIMUM TOTAL TRIHALOMETHANE POTENTIAL
Results in milligrams per liter (mg/L)

Date	Total Trihalomethanes	Chloroform	Bromodichloromethane	Chlorodibromomethane	Bromomethane
11 Jul 90	338.0	317.0	21.0	< 0.5	< 0.7

H. Best Available Technologies (BATs): A BAT is the technology, treatment technique, or other feasible means of meeting the EPA established MCL. The recommended BATs have been examined for efficacy under field conditions. EPA prescribes BATs to resolve THMs as follows:[21]

1. Precursor Removal (Adsorption)

Precursor removal using Granular Activated Carbon (an adsorption process) reduces 50% of TTHM-formation. Adsorption is the physical and/or chemical process in which a substance is accumulated at an interface between phases. For the purposes of water treatment, adsorption from solution occurs when impurities in the water accumulate at a solid-liquid interface.

During the mid-1970s, interest in adsorption as a process for removal of organics from drinking water heightened as the public became increasingly concerned about water sources contaminated by industrial wastes, agricultural chemicals, and sewage discharges. Another major concern was the observed formation of THMs and other known or suspected carcinogens during chlorination of water containing organic precursors.[15]

2. Alternate Oxidants

a. Chlorine Dioxide. Chlorine dioxide is excellent for disinfection of both bacteria and viruses and will not produce THMs.[13]

b. Chloramines. Chloramines are a moderate disinfectant for bacteria and low for viruses disinfection and are unlikely to produce THMs.[15]

Case studies in the United States have generally concluded that utilities using chloramines for disinfection have been able to meet the coliform standard in distribution systems. A number of bacterial genera have been identified in systems that use chloramines, but this is also true of systems that use free chlorine. It is difficult to predict the behavior of Metropolitan's distribution system upon conversion to chloramines, but there is enough evidence from other users throughout the United States to expect continued good water quality. In addition, combined residuals are longer lasting in distribution systems than are free chlorine residuals. For points in the distribution system where contact times are long, such as dead ends, there may be benefits in changing from free chlorine to chloramines.[9]

c. Ozone. Ozone is excellent for disinfection of both bacteria and viruses and cannot produce THMs. However, ozone does not carry a residual in the distribution system.[15]

3. By-product Removal

a. Adsorption

(See II.H.1 Above)

b. Gas Transfer (e.g., Tower Aeration). Gas Transfer (air stripping) is when a gas (air) is moved through a liquid and the substance being stripped is moved from the liquid to the gas. This is usually done with water flowing down a column that is filled with media (small, usually plastic, about the size of a quarter) with air being bubbled up the column. With the water coming down through the media and the air coming up through the water and media a mixing occurs. In the mixing process the substance (chloroform) will pass from the water to the air and be expelled. Local, state, and federal air emission standards must be met.[15]

4. Retention Time (Not a EPA BAT). Retention time in a distribution system effects the disinfection residual. The longer the water is held, the less disinfectant (chlorine) remains in solution. A shorter retention time also gives the bacteria a shorter time to multiply if the disinfectant were to dissipate. Chlorine residuals of 0.1 or 0.2 mg/L are normally maintained in water treatment plant product waters as a factor of safety for the water as it travels to the consumer.[12] Also, a distribution system with substantial flow will not acquire as thick a scum layer in the pipe as one with less flow.

I. Health Effects

The principal health effect from THMs is the potential of some to cause cancer. The only DBP identified to date as a potential carcinogen is chloroform. The most recently published evaluation of the health effects of DBPs by the National Research Council (NRC) supported the carcinogenicity of chloroform in rats. The NRC, however, discounted the original finding that chloroform causes liver tumors in mice, basing that conclusion on a more recent animal feeding study. The NRC also concluded that the chloroform concentration equivalent to a 10^{-6} cancer risk should be increased from 0.26 to 5.6 µg/L. This more than 20-fold change in the theoretical health risk of chloroform illustrates the lack of conclusive scientific evidence in this critical area. Other DBPs, including the three other THMs, did not have enough valid data to warrant classification as carcinogens or to allow cancer-risk calculations.[11]

III. RESULTS

A. Chemicals

1. Chlorodibromomethane and Bromomethane. These parameters had little effect on Stewart's total Trihalomethane (TTHM) and will not be discussed in detail.

2. Bromodichloromethane. This parameter accounts for about 10% of the TTHM. Even if all of the bromodichloromethane were eliminated, the TTHM would still be greater than the legal limit.

3. Chloroform. Chloroform accounts for over 90% of the TTHM in the system. The mean for chloroform is above the limit for TTHM and is the major point of concern.

4. TTHM. Table 5 shows the average THMs and TTHM for each sampling date.

TABLE 5
AVERAGE TRIHALOMETHANE (THM) LEVELS - SUMMARY
Results in micrograms/liter (µg/L)

Date	Total Trihalo-methanes	Chloro-form	Bromo-dichloro-methane	Chloro-dibromo-methane	Bromo-methane
05 Jul 89	105.0	96.8	8.[illegible]	< 0.5	< 0.7
02 Nov 89	114.3	99.7	13.3	1.3	< 0.7
06 Feb 90	104.8	91.8	11.8	1.1	< 0.7
10 Jul 90	120.1	111.0	8.	0.8	< 0.7
11 Jul 90	117.9	106.9	10.	1.0	< 0.7

The TTHM has an average of over 113 µg/l with a standard deviation of 13 µg/l (see Table 6). Even when applying the standard deviation, the THM limit is above the MCL.

TABLE 6
SUMMARY OF TOTAL TRIHALOMETHANE (TTHM) SAMPLE RESULTS
Results in micrograms per liter (µg/L)

Parameter	High	Low	Mean	Standard Deviation
Total Trihalomethanes	128.6	74.5	113.3	13.0
Chloroform	117.5	69.0	102.4	12.1
Bromodichloromethane	14.0	< 0.4	10.1	2.8
Chlorodibromomethane	1.4	< 0.5	0.9	0.3
Bromomethane	< 0.7	< 0.7	< 0.7	N/A

Table 7 shows the results of past THM data, and Table 8 shows the results of AFOEHL/EQW sampling.

TABLE 7
TRIHALOMETHANE (THM) LEVELS
Results in micrograms/liter (µg/L)
Sampled by base SGPB

Location	Total Trihalo-methanes	Chloro-form	Bromo-dichloro-methane	Chloro-dibromo-methane	Bromo-methane
		5 July 89			
Bldg 202	114.3	105.0	8.9	< 0.5	< 0.7
Bldg 203	120.7	111.0	9.7	< 0.5	< 0.7
Bldg 207	74.5	69.0	5.5	< 0.5	< 0.7
Bldg 403	110.3	102.0	8.3	< 0.5	< 0.7
Average	105.0	96.8	8.1	< 0.5	< 0.7
		2 Nov 89			
Bldg 203	119.4	104.0	14.0	1.4	< 0.7
Bldg 207	101.0	88.0	12.0	1.0	< 0.7
Bldg 403	122.4	107.0	14.0	1.4	< 0.7
Average	114.3	99.7	13.3	1.3	< 0.7
		6 Feb 90			
Bldg 105	84.9	76.0	8.2	0.7	< 0.7
Bldg 202	120.3	105.0	14.0	1.3	< 0.7
Bldg 203	99.2	86.0	12.0	1.2	< 0.7
Bldg 207	103.2	90.0	12.0	1.2	< 0.7
Bldg 403	116.3	102.0	13.0	1.3	< 0.7
Average	104.8	91.8	11.8	1.1	< 0.7

TABLE 8
TRIHALOMETHANE (THM) LEVELS
Results in micrograms/liter (µg/L)
Sampled by AFOEHL/EQW

Location	Total Trihalo-methanes	Chloro-form	Bromo-dichloro-methane	Chloro-dibromo-methane	Bromo-methane
		10 July 90			
Bldg 100	111.9	102.1	9.0	0.8	< 0.7
Bldg 102	127.1	116.2	10.0	0.9	< 0.7
Bldg 108	123.0	112.2	10.0	0.8	< 0.7
Bldg 202	124.1	112.5	10.6	1.0	< 0.7
Bldg 203	105.7	105.7	< 0.4	< 0.5	< 0.7
Bldg 403	128.6	117.5	10.1	1.0	< 0.7
Average	120.1	111.0	8.4	0.8	< 0.7
		11 July 90			
Bldg 100	110.1	99.8	9.4	0.9	< 0.7
Bldg 102	127.3	115.8	10.5	1.0	< 0.7
Bldg 108	117.3	106.3	10.0	1.0	< 0.7
Bldg 202	122.2	110.8	10.4	1.0	< 0.7
Bldg 203	123.5	112.1	10.4	1.0	< 0.7
Bldg 403	120.2	108.9	10.3	1.0	< 0.7
Site 019	104.6	94.7	9.1	0.8	< 0.7
Average	117.9	106.9	10.0	1.0	< 0.7

*Site 019 refers to the Aircraft Watering Point on the flightline.

5. Bromides. We found detectable amounts of bromide.

6. Total Organic Carbon. Two sites were sampled for TOC and each had a concentration of 4.0 mg/l.

7. Total Organic Halides. We analyzed three samples for TOX. Two sites had a concentration of 0.19 mg/l and the other with a concentration of 0.40 mg/l.

8. Chlorine Residual

The minimum free available chlorine residual after 10 minutes of contact time at a pH of 7.5 should be at least 0.3 mg/l.[22] The minimum combined available chlorine residual after 60 min of contact time should be 1.6 mg/l.[22] Surface water treatment requirements final rule promulgated on June 29, 1989 (54 FR 27486), will change the chlorine residual requirement.[21] The new requirement requires a detectable chlorine residual or the hetero-trophic plate count cannot be greater than 500/ml in more than five percent of the samples, each month, for any two consecutive months in the distribution system.

Zero chlorine residual was found throughout the base except at the People Center, Bldg 203. A chlorine residual is there because of heavy water consumption. The major user of water during the visit in Bldg 203 was the cafeteria.

The influent to the base had a chlorine residual of 0.2 mg/l the first day of sampling and 0.0 mg/l the second day.

B. Biological

We took no biological samples, but past data showed that some samples had tested positive. During the writing of this report, the base again reported positive samples at various locations around the base including the influent.

IV. CONCLUSIONS

The following are our comments with respect to each area addressed in the request letter.

A. Source Water Quality

The source water quality is near the limit on THM (0.10 mg/l) and would not meet the future limit for chlorine (Cl > 0.0 mg/l) one day and just met the future limit the next day.[21] Also, the TTHMs were close to the limit of 100 µg/l, (see Table 9). (During the writing of this report, coliform bacteria were confirmed at the influent to the base, with two separate samples, one with three and the other with one colony/100 ml. The base purchased this water from New Windsor. The water that AFOEHL took samples from was purchased from Newburgh.)

TABLE 9
TRIHALOMETHANE (THM) LEVELS
INFLUENT TO STEWART ANG BASE NY (BLDG 110)
Results in micrograms/liter ($\mu g/L$)

Date	Total Trihalo-methanes	Chloro-form	Bromo-dichloro-methane	Chloro-dibromo-methane	Bromo-methane
10 Jul 90	98.7	89.0	8.9	0.8	< 0.7
11 Jul 90	81.6	72.4	8.5	0.7	< 0.7
Average	90.2	80.7	8.7	0.8	< 0.7

The base is situated so that it is at the end of the distribution system from the two water plants. Not withstanding, the law requires tne supplier to distribute water to the base which meets SDWA standards.

B. Treatment Alternatives

1. New Distribution System

A new distribution system would drastically reduce the detention time and thus keep a higher chlorine residual in the water distribution system for disinfection. With this approach booster chlorination should be unnecessary, reducing THM production. If disinfection is necessary, chlorine dioxide or chloramines could be used and again no THMs would be produced. If Stewart ANG Base could receive an adequate quality of water (Cl > 0.2 mg/l) and (TTHM < 0.10 mg/l) from the supplier and put in place a suitable drinking water distribution system, this should solve the bacteriological problems along with the THMs.

2. Air Stripping, BAT Application

Super chlorination would convert the humic substances to THMs. After a sufficient retention time, the THMs could be air stripped from the water, leaving some chlorine in the water for disinfection in the distribution system. If a chlorine residual could not be maintained after stripping, booster chlorination should be applied, preferably chlorine dioxide or chloramines because of their resistance to produce THMs.

This process would be the cheapest of the BATs, but if a high enough amount of chlorine is not kept in the distribution system the bacteriological problem could reappear. With the high level of chlorine needed to keep a residual throughout the fire fighting system, chlorine taste and odor problems would occur in the high use areas.

3. Granular Activated Carbon (GAC), BAT Application

The base could apply the GAC BAT for additional treatment for the THMs and taste and odor. If the base uses GAC alone, they can expect a 50% removal of the THMs. The base should also chlorinate to keep a residual for disinfection in the system. As in air stripping, the bacteriological problem could reappear, depending on the type of GAC system they use.

4. Alternate Oxidants

Ozonation is impractical in this system because of the need for a residual disinfectant.

The base could use chlorine dioxide or chloramines instead of the present disinfectant, chlorine. This would not lower the THM level already in the influent water, but should add little or no additional THMs to the system. With higher levels coming on base, the base may still exceed limits. However, a combination of better (lower THM) source water and chloramination may resolve the problem relatively inexpensively. Chloramination would roughly double chlorination costs. This may be the best approach.

5. Combination of Alternatives

Combinations of the above treatment processes may provide the best approach (air stripping prior to GAC and then booster chlorination.) Air stripping and a new distribution system using the present chlorinator. The variations will depend on local, state, and federal laws; quality of water needed; and the amount of funds available. Also, some options will require sophisticated operator training.

C. Distribution System Layout and Water Use Trends

The distribution system and layout does not match base water use. The system was designed for 161,000 gallons a day but only 25,000 to 35,000 gallons are used. This makes the detention time too long to maintain an adequate amount of chlorine in the distribution system. It seemed that the problem came about when the runway was completed and the water (about 100,000 gallons a day) was not needed anymore for concrete production. At this time, the retention time increased and the bacteriological results started reading positive. Booster chlorination was used and solved the bacteriological problem, but the booster chlorination generated sufficient amounts of THMs to exceed the limit.

Not only will it be very hard to maintain the minimum chlorine residual in the distribution system. With the small amount of flow, no scouring occurs and a large scum layer can form on the lining of the pipe. Flushing only dislodges the scum layer and moves it to a new location. Even with a fire hydrant wide open the amount of flow in a 24-inch pipe is quite low. This scum layer could become a sanctuary for bacteria if a sufficient chlorine residual is not maintained.[5]

D. Monitoring Procedures

The clinic's current monitoring procedures have been sufficient, but they will need to update them as EPA finalizes new SDWA MCLs.

V. RECOMMENDATIONS

A. Pursue legal and/or contractual means to obtain source water which meets Federal and State standards.

B. Treatment

1. Try switching to chloramines.

2. Super chlorinating, air stripping, and rechlorinating appear to be the next least expensive treatment alternative. This would eliminate the THM problem but would not guarantee that a chlorine residue for disinfection could be maintained in the distribution system.

3. The alternative which best guarantees water quality under present and future regulations is to install a separate potable water line.

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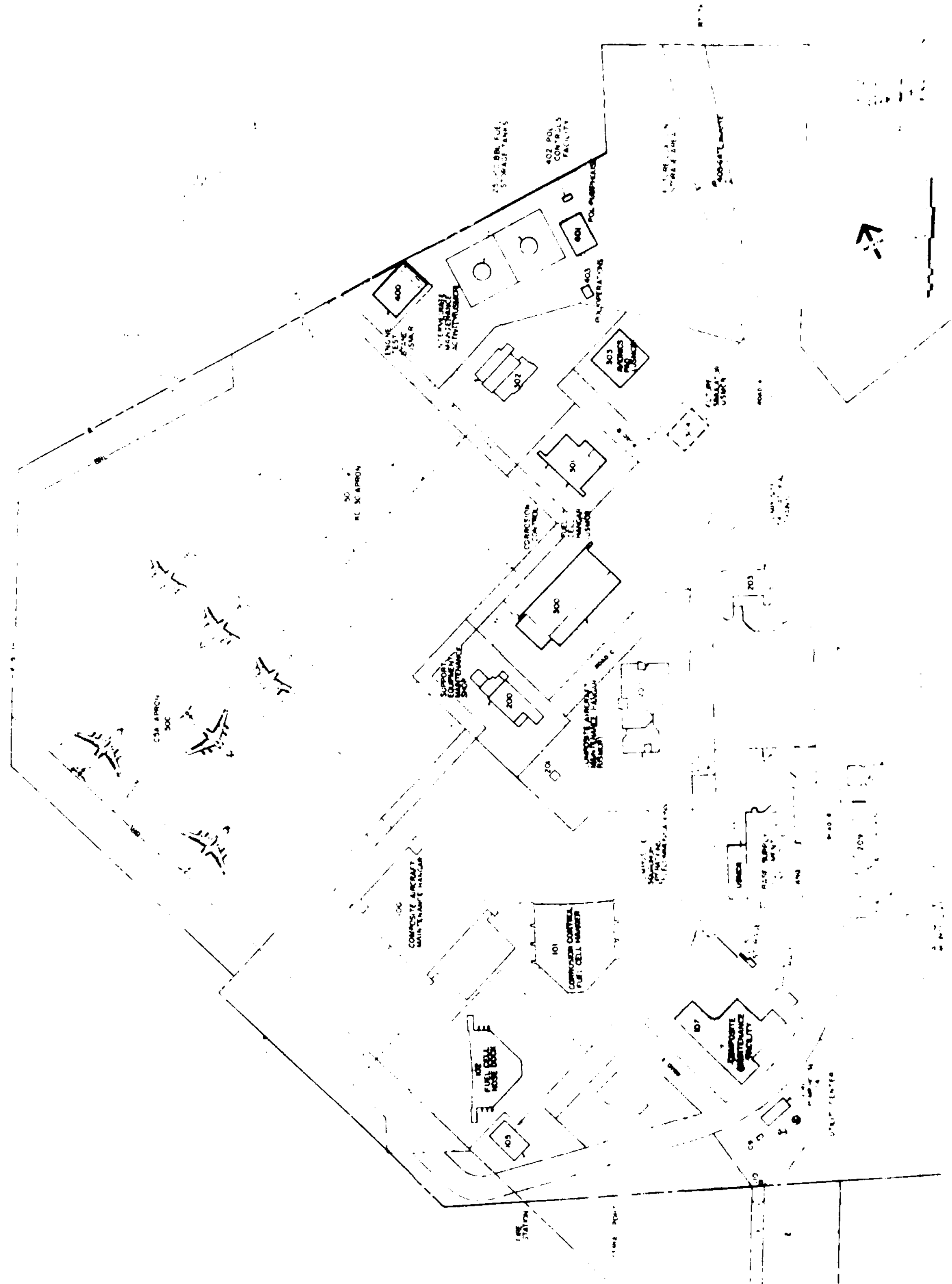
Appendix A

Base Map



Appendix B

Sampling Logs

SAMPLE LOG
AFOEHL ENVIRONMENTAL QUALITY DIVISION
WATER QUALITY SURVEY - STEWART ANG BASE NY
9 - 11 JUL 90

SITE DESCRIPTION	SAMPLE NUMBER	DATE COLLECTED	ANALYSIS	COLLECTED BY	AFOEHL SAMPLE NUMBER	RESULTS RECEIVED
Bldg 110, Pumphouse	GP-90-0101	10 Jul 90	Group A	MSG Randall	90043942	23 Jul 90
Bldg 110, Pumphouse	GP-90-0101	10 Jul 90	Group G	MSG Randall	90043943	23 Jul 90
Bldg 110, Pumphouse	GP-90-0101	10 Jul 90	TTHM	MSG Randall	90043952	30 Jul 90
Bldg 110, Pumphouse	GP-90-0101	10 Jul 90	MTP	MSG Randall	N/A	Not Analyzed
Bldg 110, Pumphouse	GP-90-0101	10 Jul 90	TOX	MSG Randall		
Bldg 108, Utility Center	GP-90-0102	10 Jul 90	Group A	MSG Randall	90043944	23 Jul 90
Bldg 108, Utility Center	GP-90-0102	10 Jul 90	Group G	MSG Randall	90043945	23 Jul 90
Bldg 108, Utility Center	GP-90-0102	10 Jul 90	TTHM	MSG Randall	90043953	30 Jul 90
Bldg 108, Utility Center	GP-90-0102	10 Jul 90	MTP	MSG Randall	N/A	Not Analyzed
Bldg 108, Utility Center	GP-90-0102	10 Jul 90	TOX	MSG Randall		
Bldg 403, POL Operations	GP-90-0103	10 Jul 90	TTHM	MSG Randall	90043954	30 Jul 90
Bldg 100, CAMS Hangar	GP-90-0104	10 Jul 90	TTHM	MSG Randall	90043955	30 Jul 90
Bldg 102, Fuel 11 Hangar	GP-90-0105	10 Jul 90	TTHM	MSG Randall	90043956	30 Jul 90
Bldg 202, Squadron Operations	GP-90-0106	10 Jul 90	TTHM	MSG Randall	90043957	30 Jul 90
Bldg 203, People Center	GP-90-0107	10 Jul 90	TTHM	MSG Randall	90043958	30 Jul 90
Bldg 110, Pumphouse	GP-90-0108	11 Jul 90	Group G	MSG Randall	90043946	23 Jul 90
Bldg 110, Pumphouse	GP-90-0108	11 Jul 90	TTHM	MSG Randall	90043959	30 Jul 90
Bldg 110, Pumphouse	GP-90-0108	11 Jul 90	MTP	MSG Randall	90046114	27 Jul 90
Bldg 110, Pumphouse	GP-90-0108	11 Jul 90	TOX	MSG Randall		
Bldg 108, Utility Center	GP-90-0109	11 Jul 90	Group G	MSG Randall	90043947	23 Jul 90
Bldg 108, Utility Center	GP-90-0109	11 Jul 90	TTHM	MSG Randall	90043960	30 Jul 90
Aircraft Watering Point	GP-90-0110	11 Jul 90	Group G	MSG Randall	90043948	23 Jul 90
Aircraft Watering Point	GP-90-0110	11 Jul 90	TTHM	MSG Randall	90043961	30 Jul 90
Bldg 203, People Center	GP-90-0111	11 Jul 90	TTHM	MSG Randall	90043962	30 Jul 90
Bldg 100, CAMS Hangar	GP-90-0112	11 Jul 90	TTHM	MSG Randall	90043963	30 Jul 90
Bldg 102, Fuel Cell Hangar	GP-90-0113	11 Jul 90	TTHM	MSG Randall	90043964	30 Jul 90
Bldg 202, Squadron Operations	GP-90-0114	11 Jul 90	TTHM	MSG Randall	90043965	30 Jul 90
Bldg 403, POL Operations	GP-90-0115	11 Jul 90	TTHM	MSG Randall	90043966	30 Jul 90

FIELD MEASUREMENTS LOG
AFOEHL ENVIRONMENTAL QUALITY DIVISION
WATER QUALITY SURVEY - STEWART ANG BASE NY
9 - 11 JUL 90

SITE DESCRIPTION	SAMPLE NUMBER	DATE COLLECTED	TIME COLLECTED	(°F) TEMP	FREE AVAILABLE CHLORINE (ppm)	TOTAL RESIDUAL CHLORINE (ppm)	pH	TTHM (ug/L)
Bldg 110, Pumphouse	GP-90-0101	10 Jul 90	1412	60	0.1	0.2	7.3	98.7
Bldg 108, Utility Center	GP-90-0102	10 Jul 90	1440	62	0.6	0.8	7.3	123.0
Bldg 403, POL Operations	GP-90-0103	10 Jul 90	1455	60	0.0	0.0	7.5	128.6
Bldg 100, CAMS Hangar	GP-90-0104	10 Jul 90	1515	76	0.0	0.0	7.5	111.9
Bldg 102, Fuel Cell Hangar	GP-90-0105	10 Jul 90	1530	60	0.0	0.0	7.3	127.1
Bldg 202, Squadron Operations	GP-90-0106	10 Jul 90	1545	66	0.0	0.0	7.5	124.1
Bldg 203, People Center	GP-90-0107	10 Jul 90	1600	64.	0.2	0.4	7.5	105.7
Bldg 110, Pumphouse	GP-90-0108	11 Jul 90	0930	60	0.0	0.0	7.3	81.6
Bldg 108, Utility Center	GP-90-0109	11 Jul 90	0940	62	0.5	0.6	7.3	117.3
Aircraft Watering Point	GP-90-0110	11 Jul 90	0915	65	0.0	0.0	7.8	104.6
Bldg 203, People Center	GP-90-0111	11 Jul 90	0825	62	0.2	0.4	7.5	123.5
Bldg 100, CAMS Hangar	GP-90-0112	11 Jul 90	0950	61	0.0	0.0	7.5	110.1
Bldg 102, Fuel Cell Hangar	GP-90-0113	11 Jul 90	1000	68	0.0	0.0	7.3	127.3
Bldg 202, Squadron Operations	GP-90-0114	11 Jul 90	1010	65	0.0	0.0	7.5	122.2
Bldg 403, POL Operations	GP-90-0115	11 Jul 90	1020	60	0.0	0.0	7.5	120.2

Appendix C

Environmental Acronyms and Abbreviations

Environmental Acronyms and Abbreviations

AFOEHL	Air Force Occupational and Environmental Health Laboratory
BAT	Best Available Technology
CWA	Community Water System
DBP	Disinfection By-products
GAC	Granular Activated Carbon
MCL	Maximum Contaminant Level
mg	Milligrams
MTP	Maximum Total Trihalomethane Potential
NPTOC	Non-purgeable Total Organic Carbon
NRC	National Research Council
NTNC	Nontransient Noncommunity Water System
SDWA	Safe Drinking Water Act
THM	Trihalomethane
TTHM	Total Trihalomethane
TOC	Total Organic Carbon
TOX	Total Organic Halides
USEPA	U.S. Environmental Protection Agency
$\mu g/L$	Micrograms Per Liter
°C	Degrees Centigrade

Appendix D

Request Letter

NEW YORK AIR NATIONAL GUARD
HEADQUARTERS 105th MILITARY AIRLIFT GROUP
STEWART AIR NATIONAL GUARD BASE
ONE MILITIA WAY
NEWBURGH, NEW YORK 12550 5043

REPLY TO
ATTN OF: CC

30 April 1990

SUBJECT: Request for OEHL Service

TO: USAF OEHL/CC
Brooks AFB TX 78235-5501

1. Request your assistance in identifying causes and recommending solutions to an abnormal water quality condition that exists at Stewart Air National Guard Base. The following background information is provide:

a. The 105th Military Airlift Group is the host organization with a C-5 aircraft mission. The 42nd Marine Aircraft Group, Det D, is the only tenant organization with a KC-130T aircraft mission. Total daily population is over 800 and peaks at 1700 during monthly unit training assemblies.

b. The base, including all utility systems, is a totally new facility. Construction started in 1984. It is almost complete except for a motor vehicle building that will be finished later this year, an aerial port building scheduled for construction in August 1990, and a C-130 fuel cell hanger in September 1990. Occupancy of buildings started in October 1987, and continued as each of the current 13 buildings were completed.

c. The base water storage is contained in two 250,000 gallon tanks. The same tanks and water lines are used for supplying water to both buildings and the fire suppression system. The base receives treated water from the surrounding communities. The water is also chlorinated while maintained in the base water tanks.

d. Abnormal potable water conditions in the buildings were first detected in September 1988. Several buildings experienced varying degrees of low to nonexistent residual chlorine, periodic coliform bacteria presence and non coli form growth. Attempts to correct the conditions included raising the chlorine levels in the storage tanks and rerouting the water flow to some of the buildings. These actions and the colder weather in the winter months did reduce the abnormal conditions; however, some of these same buildings are now experiencing unacceptable levels of trihalomethane, probably due to the additional chlorination.

2. Based on recommendations from both the Base Civil Engineer and Bioenvironmental Engineering Technician, request that your assistance include a survey team to visit Stewart ANG Base in the near future to evaluate the following areas:

a. Source water quality.

b. Treatment processes.

c. Distribution system and layout.

d. Water use trends.

e. Monitoring procedures.

3. POC's for coordination, copies of historic water monitoring data, engineering data and any other necessary information are:

a. Lt Col William Steene, Civil Engineer, AV 247-2888.

b. TSgt Jan Brown, Bioenvironmental Engineering, AV 247-2151.

PAUL A. WEAVER, JR., Colonel, NYANG
Commander

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